Sun Acq/402.5 Km BOOST Timeline

(All times are in GMT)

On 01-225 at 02:21:57z, ACS FDC Test 23 reached its first limit and triggered FDC Action 28, which notifies the ground and marks DSS-A (Fore DSS) Bad. Less than two minutes later at 02:23:30, FDC Test 58 (ESA Quadrant 1 Static Tolerance Check) reached its first limit and triggered FDC Action 2, which switched to ACE-B telemetry and control. Spacecraft monitor TSM 10 properly detected that ACE-B was in control, and it in turn activated RTS 6 at 02:23:34, which switches to the ACE-B data storage filter table, disables ACE-A Safehold monitoring, and enables ACE-B Safehold monitoring. FDC Test 59 (ESA Quadrant 2 Static Tolerance Check) also reached its first limit at 02:23:48, but no further action was taken because FDC Test 58 had already activated FDC Action 2.

FDC Test 58 reached its second limit at 02:26:14, which triggered FDC Action 30 and set the ESA Quadrant 1 status to Bad. Shortly afterward, FDC Test 59 also reached its second limit, triggering FDC Action 31, which flagged ESA Quadrant 2 Bad. Forty-five minutes after FDC Test 23 reached its first limit at 03:06:57, FDC Test 24 also reached its first limit, triggering FDC Action 29. This action notifies the ground and marks DSS-B (Aft DSS) Bad. Once both DSSs are simultaneously marked Bad, FDC Test 25 triggers, which activates FDC Action 27. This final action marked the Ephemeris Bad and transitioned the spacecraft to Sun Acquisition control mode at 03:08:04. At that point, the standard Loadshed sequence of events began: TSM 16 detected entry into Sun Acquisition, and activated RTS 5 which in turn activated RTS 3. FDC Tests 110 and 111 generated event messages as the solar arrays slewed to the 90° Index position and passed the operational 50° software stops. RTS 3 stops the ATS Load, activates the Loadshed RTS 14 (which in turn activates RTSs 13 and 15), turns off transmitter 1, feathers the High Gain Antenna (HGA), turns on transmitter 2 set for the low rate 1/1 kbps omni configuration, and enables the ACE-B monitor TSM 11. TSM 11 did activate at 03:09:56, since ACE-B was in control at that point. This TSM uses RTS 7 to switch the Telemetry Output (TO) filter table to the ACE-B configuration (more ACE-B packets, and less ACE-A packets) of Table 2.

These FDCs triggered following three days of successful Delta-V Boost burns which placed the TRMM spacecraft into a new higher orbit of 386.90 km x 379.84 km. At this new altitude, the Barnes static Earth Sensor Assembly (ESA) has a lower signal to noise ratio than at the operational 354 x 347 km orbit. The ESA always produces spikes in roll and pitch position error during transitions between three and four quadrant control due to an anomalous behavior with the internal Offset Radiation Source (ORS). These transitions occur whenever there is predicted sun and/or moon quadrant interference. However, these spikes became much larger due to the increased sensitivity at the new altitude and on 01-225, a larger than usual roll error was produced which eventually translated into yaw. As a result, the observatory was no longer pointing directly along the velocity vector, and there was an accumulated error that exceeded the FDC minimum 2 degrees. Yaw gyro drift corrections commonly known as yaw updates normally occur twice an orbit centered around orbit noon using the Fore and Aft DSSs to correct for the yaw gyro drift. However, due to the large yaw error that was induced from the last ESA spike, the yaw update scheduled for 02:21:57 did not occur and FDC Test 23 triggered, assuming there was a 'problem' with the DSS-A. Without a correction in yaw, this error continued to propagate

through the orbit and as a result, the next yaw update did not occur either, sending the spacecraft to Sun Acquisition mode. The fact that two ESA quadrants were flagged bad also indicates that there was a large accumulated yaw error and the spacecraft was no longer properly pointing at the earth. After performing simulations for Sun Acquisition exit, 3 min ΔV burns, and a Yaw maneuver test while in contingency mode, the decision was made to recover back to normal mode and continue the boost activities without using the ESA.

Anomaly Timeline

01-225 (Monday, August 13th 2001)

1. ACS FDC Test #23, reaches 1st limit and triggers FDC Action #28, which marks DSS-A bad   02:21:57
2. ACS FDC Test #58 reaches 1st limit and triggers FDC Action #2, which places ACE-B in control   02:23:30
3. S/C TSM #10, triggers RTS #6, Continues failover process to ACE-B   02:23:34
4. ACS FDC Test #59, trips but FDC Action #28 disabled   02:23:48
5. ACS FDC Test #58 reaches 2nd limit and triggers FDC Action #30, which sets ESA Quadrant 1 status to Bad   02:26:14
6. ACS FDC Test #59 reaches 2nd limit and triggers FDC Action #31, which sets ESA Quadrant 2 status to Bad   02:26:16
7. ACS FDC Test #23 reaches 1st limit, and ACS FDC Test #24 reaches 1st limit and triggers ACS FDC Action #29, which marks DSS-B Bad.   03:06:57
8. ACS FDC Action triggers ACS FDC Action #27, which marks the Ephemeris bad and transitions the S/C to Sun Acquisition mode.   03:08:04
9. TSM 16 detects Sun Acquisition mode, and begins Loadshed procedures
10. VR 1: Housekeeping Recorder Overflows   07:06:42

Recovery Timeline

Note: Offline activities such as simulations are not included in this timeline.

01-225 (Monday, August 13th 2001)

1. EPV Uplinked   12:36:02
2. ADSS_CONFIG procedure started   12:42:03
    DSS-A marked GOOD   12:42:13
    ADSS_CONFIG procedure competed
3. ADSS_CONFIG procedure started   12:43:27
    DSS-B marked GOOD   12:43:35
    ADSS_CONFIG procedure competed

4.	Yaw Update Selection to use Both DSSs	12:44:36
5.	EPV Started	12:47:21
6.	EPV Executing	13:00:00

01-226 (Tuesday, August 14th 2001)

1.	S/C TSM #10 Disabled	18:33:37
2.	S/C TSM #11 Disabled	18:33:51
3.	ACEB_TO_A procedure started	18:34:47
	ACS FDCs Disabled	18:35:05
	ACS Select ACE-A	18:35:52
	ACE-A Take Control	18:37:30
	ACE-B Take Control	18:37:31
	ACE-A Take Control	18:37:36
	DS Filter Table Changed to #1	18:38:01
	GASASH ACEA	18:39:21
	ACS FDCs Enabled	18:41:48
	ACS FDC Test #23 enabled	18:43:21
	ACS FDC Test #24 enabled	18:44:27
	ACS FDC Test #25 enabled	18:44:55
	ACS FDC Test #58 enabled	18:45:21
	ACS FDC Test #59 enabled	18:45:42
	ACS FDC Action #27 enabled	18:46:46
	ACS FDC Action #28 enabled	18:47:10
	ACS FDC Action #29 enabled	18:47:32
	ACS FDC Action #30 enabled	18:47:51
	ACS FDC Action #31 enabled	18:48:17
	ACS FDC Action #2 enabled	18:48:32
	ACS FDC Action #5 enabled	18:48:51
	TSM Monitor #13 Disabled	18:10:17
	TSM Monitor #12 Reset	18:10:17
	TSM Monitor #10 Reset	18:10:17
	ACEB_TO_A procedure competed	
4.	All ESA Quadrants marked GOOD	19:05:24

01-228 (Thursday, August 16th 2001)

1.	ACONTINGENCY_ENTER procedure started	16:41:11
	ACS Table #102 loaded to RAM	16:43:42
	ACS Table #81 loaded to RAM	16:45:20
	ACS Table #80 loaded to RAM	16:45:59
	ACS Table #90 loaded to RAM	16:46:39
	ACONTINGENCY_ENTER procedure competed	

2. SDSQUOTA procedure started   16:48:10
    DS Filter Table Changed to #4   16:48:11
    DS Data Set #0 Closed and Data Set #1 Released   16:48:27
   SDSQUOTA procedure competed
3. S/C Table #73 loaded to RAM   16:49:36
4. DS Filter Table Changed to #1   16:48:11
5. STCUTCFADJ_USCCS procedure started   17:54:19
    S/C Clock-B Adjusted By -890 us sent   17:56:51
   STCUTCFADJ_USCCS procedure competed
6. ACONTINGENCY_ENTER procedure started   18:31:18
    Kalman Filter Initialize sent (Sun Acq, and in Sunlight)   18:33:03
   ACONTINGENCY_ENTER procedure competed

01-229 (Friday, August 17th 2001)

1. ACONTINGENCY_ENTER procedure started   13:19:38
    Kalman Filter Initialize sent (Sun Acq, and in Eclipse)   13:22:11
   ACONTINGENCY_ENTER procedure competed
2. ACS µP RAM memory dump   15:36:21
3. ACS Table #54 Loaded to RAM   15:40:57
4. ACGOTOEARTH procedure started   17:11:27
    Set Mission Phase to Mission sent   17:11:41
    Set Target Orientation to +X forward sent   17:12:05
    S/C Transition to Earth Acq sent   17:12:38
    S/C Control Mode Enters: Earth Acq Mode   17:14:13
    S/C Control Mode Enters: Yaw Acq Mode   17:24:20
    S/C Control Mode Enters: Nominal Mission Mode   17:25:23
   ACGOTOEARTH procedure competed
5. AFDC_CONFIG procedure started   17:26:57
    ACS FDC Test #110 enabled   17:27:21
    ACS FDC Test #111 enabled   17:28:10
    ACS FDC Test #110 reset   17:28:50
    ACS FDC Test #111 reset   17:29:27
   AFDC_CONFIG procedure competed
6. S/C RTS #3 Enabled   17:33:46
7. S/C RTS #5 Enabled   17:34:29
8. S/C RTS #14 Enabled   17:34:35
9. S/C RTS #15 Enabled   17:34:41
10. TSM Monitor #16 Reset   18:10:17
11. AFDC_CONFIG procedure started   18:11:15
    ACS FDC Action #35 enabled   18:11:38
   AFDC_CONFIG procedure competed

12. EIATMRSTMM, EIBTMRSTMM, EIATMBDEN EIBTMBDEN sent
    (In place of wlowpwrrecovery procedure)   18:13:00
13. ACONTINGENCY_ENTER procedure started   18:40:05
        Kalman Filter Initialize sent (Normal mode, and in Sunlight)   18:42:44
    ACONTINGENCY_ENTER procedure competed
14. ACS Table #51 Loaded to RAM   20:16:34
15. WPR_RFPS_RELAY procedure started   20:17:30
        TMI-A Survival Heaters OFF   20:17:50
        TMI-B Survival Heaters OFF   20:17:57
        WBNEBADS sent   20:18:28
        PAAPSPWRON sent   20:18:58
        WBNEBAEN sent   20:19:08
        WBNEBBDS sent   20:20:16
        PBBPSPWRON sent   20:20:54
        WBNEBBEN sent   20:21:01
        TMI-A Survival Heaters ON   20:21:12
        TMI-B Survival Heaters ON   20:21:12
    WPR_RFPS_RELAY procedure competed
16. MPWRON procedure started   20:22:03
        TMI-A Survival Heaters OFF   20:22:19
        TMI-B Survival Heaters OFF   20:22:25
        TMI Power ON   20:22:40
        Instrument Bus counter reset   20:22:57
    MPWRON procedure completed
17. MSPINUP procedure started   20:23:34
        TMI Spin-Up State ON   20:23:56
    MSPINUP procedure completed
18. MRCVRSON procedure started   20:26:55
        TMI Receiver ON   20:26:56
    MRCVRSON procedure completed
19. PRSTARTON procedure started   20:28:12
        PRSURVHTRS procedure started   20:28:19
            Disabled K1 survival heater   20:29:00
        PRSURVHTRS procedure completed
        SCDP Powered ON   20:29:53
        FCIF Powered ON   20:31:37
        RF Power Supply ON   20:31:56
        PR in STANDBY   20:32:46
        Command Lock ENABLE   20:33:21
        PTXCODE103 procedure started   20:34:16
        PTXCODE103 procedure completed
        PRXCODE103 procedure started   20:40:11
        PRXCODE103 procedure completed

Command Lock DISABLE	20:46:05
PR in OBSERVATION	20:46:18
PRSTARTON procedure completed	
20. PRXATTN SEL9DB	20:47:19
21. RCS High Pressure Transducer ON	20:50:12
22. AFDC_CONFIG procedure started	21:26:32
ACS FDC Test #23 disabled	21:27:05
ACS FDC Test #24 disabled	21:27:39
ACS FDC Test #25 disabled	21:28:10
AFDC_CONFIG procedure competed	
23. VPWRON procedure started	21:28:43
VIRS Power ON	21:28:51
VPWRON procedure completed	
24. VNORMOUTGAS procedure started	21:29:34
VIRS Radiator Cooler Door Select Drive-A sent	21:29:53
VIRS Radiator Cooler Door Outgas sent	21:30:07
VIRS Intermediate Stage Heater OFF sent	21:30:30
VIRS Outer Stage Heater OFF sent	21:30:44
VIRS Outgas Mode Enabled sent	21:30:53
VIRS Mounting Ring Heater ON sent	21:31:05
VNORMOUTGAS procedure completed	
25. VOPSHTRS procedure started	21:31:59
VIRS 8.5w Heater ON	21:32:11
VOPSHTRS procedure completed	
26. LPWRON procedure started	21:34:38
LIS Power ON	21:34:47
LTHRESH procedure started	21:35:39
LIS Thresh Adjustments sent	21:35:48
LTHRESH procedure completed	
LPWRON procedure completed	
27. LISCONFIG procedure started	21:36:19
Watch Dog Enabled	21:36:29
Watch Dog Timeout Set	21:36:50
LTHRESH procedure started	21:37:23
LIS Thresh Adjustments sent	21:37:34
LTHRESH procedure completed	
LIS Background Set to 8Kbps sent	21:38:02
LIS Heater Auto-Select Disabled	21:38:25
LISCONFIG procedure completed	
28. PRNGOFFSET procedure started	21:59:30
PR Command Lock Enabled	21:59:33
PR Bin #1 Angle Offset Adjusted	21:59:52
PR Bin #2 Angle Offset Adjusted	22:00:55

PR Bin #3 Angle Offset Adjusted	21:01:50
PR Bin #4 Angle Offset Adjusted	21:02:53
PR Bin #46 Angle Offset Adjusted	21:03:49
PR Bin #47 Angle Offset Adjusted	21:04:47
PR Bin #48 Angle Offset Adjusted	21:05:45
PR Bin #49 Angle Offset Adjusted	21:06:46
PR Command Lock Disabled	21:07:46
PRNGOFFSET procedure completed	
29. VOUTGAS_HTRS procedure started	23:05:24
VIRS Intermediate Stage Heater ON	23:05:41
VOUTGAS_HTRS procedure competed	

01-230 (Saturday, August 18th 2001)

1. VOUTGAS_HTRS procedure started	00:52:06
VIRS Outer Stage Heater ON	00:53:41
VOUTGAS_HTRS procedure competed	

01-231 (Sunday, August 19th 2001)

1. VINITOUTGAS_END procedure started	13:22:58
VIRS Intermediate Stage Heater OFF	13:23:05
VIRS Outer Stage Heater OFF	13:23:10
VINITOUTGAS_END procedure completed	
2. VRADCDROP procedure started	13:25:12
VIRS Radiator Cooler Door OPEN sent	13:25:37
VRADCDROP procedure competed	
3. VOUTGAS_HTRS procedure started	17:45:14
VIRS Mounting Ring Heater OFF	17:45:28
VIRS Outgas Mode Disabled	17:45:28
VOUTGAS_HTRS procedure completed	
4. VMISSMD procedure started	17:46:16
VIRS Time Patch 1 sent	17:46:35
VIRS Time Patch 2 sent	17:46:49
VIRS Scan Drive ON sent	17:47:08
VMISSMD procedure completed	
5. VSHUTTER procedure started	17:47:47
VIRS Safehold Shutter Open sent	17:47:53
VSHUTTER procedure completed	
6. VLWIRGAIN ATTENUATE sent	17:48:40
7. VSERVOMODE LOW sent	17:49:27
8. VIRS Solar Cal Door Bump Open sent	17:50:30
9. VINFOFLGRST sent	17:51:00

10. PRSURVHTRS procedure started   17:53:01
       PR Safehold Heater Enable sent   17:53:20
     PRSURVHTRS procedure completed